'One World Experiment' on the Astrtonomy Outreach : Diffence in Response to Ingroup and Outgroup

‘One World Experiment’ on the Astronomy Outreach - Difference in Response to Ingroup and Outgroup -

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The astronomy outreach project, ‘One World Experiment’, was carried out on 938 students in South Africa from October to November 2015. Based on this project, our study tests whether exposure to an astronomy intervention affects the feelings such as empathy and altruism in children by using assessment measures composed of donation voting trial and questionnaires. The intervention focuses on introducing children to astronomical perspectives of the Earth’s position in the universe. This paper describes the auxiliary analysis on possible difference between ingroup and outgroup in the response to the parts of assessment measures. Effects of astronomy intervention are not included in this paper. For the analysis, we focus on some questions from the assessment measures which ask about the strength of student’s cohesion with a child from ingroup or outgroup. The strength and direction of the linear relationship among the results of answer to questions were examined by correlation analysis. It is found that there is a strong cohesion with a South African child among all the students while those who show more behavior helping a child from other groups (in this case, nationalities) than a South African child display strong cohesion irrespective of the nationality of the child. Furthermore, it is confirmed that their impressions of how ingroup or outgroup shares the joy with them are mutually correlated. In other words, there is no nationality bias about their feelings that others share the joy with them.

***Key Words**: Astronomy, science communication, intergroup bias, South Africa, evaluation*

１．Introduction

From October to November 2015, the astronomy outreach project, ‘One World Experiment’, was carried out on 938 Black South African student s of 4th grade in Khayelitsha township, Western Cape, South Africa. One World Experiment is a collaborative project being carried out by the International Astronomical Union Office of Astronomy for Development (IAU-OAD) [1], the South African Astronomical Observatory (SAAO)’s SALT Collateral Benefits Division [2], and Hosei University Graduate School of Science and Engineering [3].

Xenophobia, which is a strong antipathy or aversion to strangers or foreigners, is one of the contemporary and serious issues in South Africa (Kapp, 2008) [4]. Our study tests whether exposure to an astronomy intervention affects intergroup biases and other-regarding preferences (empathy and resource allocation) in children.

The intervention focuses on introducing children to astronomical perspectives of the Earth’s position in the greater cosmos, namely a view of the Earth from space appearing as a pale blue dot (Sagan, 1994) [5]. The objectives of the intervention are to foster the development of an ingroup social identity amongst children based on identification with a “common humanity”; reduce salience of national and ethnic identities; and increase empathy and prosociality towards individuals in different national groups. Primary outcome of our study is whether there is any immediate effect of the intervention on children’s behavior helping anonymous ingroup versus outgroup members.

Our study includes a variety of assessment measures to evaluate the impact of astronomy outreach. Measurements are composed of two parts: Voting and Questionnaires.

The astronomy intervention is preceded or followed by the measurement, for the control and experimental groups, respectively. The control group receives the measurement first, followed by the astronomy intervention. The experimental group is administered the astronomy intervention followed by measurement. The unit of intervention is a school class (approximately 40 students per class group). Each class is assigned to the control or experimental group at random. Outcomes will be examined by comparison of the

measurement results between the control and experimental group. At schools, the astronomy intervention and the measurement were carried out by an experienced astronomy teacher from the South African Astronomical Observatory in Xhosa (isiXhosa), which is one of the official languages of South Africa and English.

Gathering data from students in South Africa were finished on 24th November 2016. Full analysis of the data which focuses on the impact of astronomy intervention is under way within the collaboration. This paper describes the auxiliary analysis on possible difference in response to Ingroup and Outgroup of children's response to the parts of assessment measures with no reference to the astronomy intervention by dealing with experimental and control groups all together. Correlation analysis was performed to examine the strength and direction of the linear relationship among the results of answer to questions.

2. Methods

(1) Data Collection

The data were gathered from 938 students (472 boys and 466 girls). After removing the incomplete data, the data from 685 students (321 boys and 364 girls) were used in this research. Assessment measures involve two parts: Voting and Questionnaires.

a) Voting

This is intended to test the helping behavior of the children towards children from other groups (in this case, nationalities). Each student has a card with envelopes affixed under a gender-neutral picture of a child from South Africa (ingroup) and a child from other parts of Africa (outgroup) as shown in figure 1. Students are given three plastic tokens representing the money. They are told that whichever envelope they may put the token in, a real donation of that amount will be made to the child whose envelope they chose.

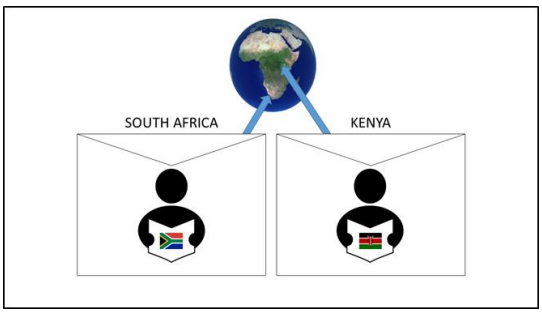

Figure 1 Voting card. Reproduced with permission from the One World Project.

b) Questionnaires

Students are asked to mark responses to the following Likert scale questions on separate cards. There are two sets of five questions, one for the home country (South Africa) and the other for other parts of African country. The intervention provider explains each question.

Question 1. How similar do you think this child is to you?

A. Very different / B. A little different / C. Neither different nor similar / D. More similar than different / E. Very similar

Question 2. How do you feel if something good happens to this child?

A. I don't care at all / B. I feel neutral, okay with it / C. I feel happy / D. I feel very happy / E. I feel very very happy

Question 3. If something good happens to you, how do you think this child feels?

A. The child doesn't care at all / B. The child feels neutral, okay with it / C. The child feels happy/ D. The child feels very happy / E. The child feels very very happy

Question 4. How much would you like to play with this child?

A. Not at all / B. A little bit / C. Medium / D. I would like to / E. I would really like to

Question 5. How would you feel if this child got hurt at school?

A. I feel very sad / B. I feel sad / C. I feel medium (not happy) / D. I don't care

c) Outgroup

We needed to select outgroup targets. We chose Kenya as the outgroup because it is an outgroup with which the children are somewhat familiar, but that is not associated with overtly negative or positive stereotypes, the scale of economy is not different far from, and does not differ along the race dimension.

d) Abbreviations

Abbreviations as shown below are used in our research.

q[n]SA, q[n]K (n: question number)

e.g. q1SA means the question number 1 and this child in this question sentence means South African child (the ingroup).

e.g. q5K means the question number 5 and this child in this question sentence means Kenyan child (the outgroup).

Abbreviations of classification with the number of students

[All]：All student (685)

[Boy]：Boy students (321) [Girl]：Girl students (364)

[vote_SA]：Students who vote more token to South African child than Kenyan child (541)

[vote_K]：Students who vote more token to Kenyan child than South African child (144)

e) Confidentiality, Protection, and Informed Consent

No data are collected from either any school or any of the children in the school can be identified. All the publications based on this study only present summary statistics and ensure that neither any school or any of the children are identifiable. Participation in this study is entirely voluntary. Schools which take part in our project can refuse or, even if they agree to take part, they change their mind later. If

they refuse to be part of the study or change their mind, we will not collect any measurements when we visit. Any child who does not wish to take part is free to refuse to participate. Activities may still be offered in future but data will not be collected from any school or individual child who say that they do not wish to take part. Consent for participation can be withdrawn at any time until results are published. If they wish to withdraw from the study, they can simply send an e-mail the OAD director Kevin Govender and tell him they wish to withdraw. They do not need to explain why.

(2) Data Analysis Procedure

In this paper, four questions (q2SA, q2K, q3SA, and q3K) are focused on, and associations among answer results of them are examined. For data analyses, the results of answer options (A, B, C, D, and E) were converted into ordinal variables (1, 2, 3, 4, and 5). From these four questions, two questions are chosen as question combinations. There are 6 question combinations, [q2SA-q2K], [q3SA-q3K], [q2SA-q3SA], [q2K-q3K], [q2SA-q3K], and [q3SA-q2K]. For Instance, [q2SA-q2K] means the association of the answer result between q2SA and q2K. To perform statistical analyses, R [6] was used in this paper. R is a software environment for statistical computing and graphics.

a) Calculating Spearman rank correlation coefficient

In correlation analysis, a sample correlation coefficient is calculated. By calculating Spearman rank correlation coefficient which is used for ordinal variables including Likert scales, the direction and strength of the association between two variables are quantified. The formula of Spearman rank correlation coefficient is:

$$r_s = \frac{\sum_i (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_i (x_i - \bar{x})^2 \sum_i (y_i - \bar{y})^2}} \quad (1)$$

r_s : Spearman rank correlation coefficient
x, y : Variables
i : Paired score

The correlation coefficient ranges between -1 and +1. The more the value of the correlation coefficient is closer to +1 or -1, the more a strong positive or negative correlation is indicated between two variables. According to Cohen (1992) [7], rules of thumb for interpreting the correlation coefficient was provided:

$|r| = .10$ small $|r| = .30$ medium $|r| = .50$ large

b) Detecting Multicollinearity using Variance Inflation Factors (VIFs)

Multicollinearity is a phenomenon of very high intercorrelations among variables. Multicollinearity can lead to problems, including overestimation of the standard error. The variance inflation factor (VIF) is an indicator for testing whether multicollinearity is present or not. The VIF of two variables is calculated by the following equation:

$$VIF_{xy} = \frac{1}{1 - r_{xy}^2} \quad (2)$$

x, y : Variables
VIF_{xy} : VIF of x and y
r_{xy} : Correlation coefficient between x and y

According to Rogerson (2001) [8], the VIF which is greater than about 5 indicates the multicollinearity.

c) Calculating Partial correlation coefficient using Spearman rank correlation coefficient

When the correlation analysis is performed by calculating the correlation coefficient, two variables are influenced by other variables. The partial correlation coefficient can avoid the influence on two variables affected by other factors. When the association between variable y and z is examined, $r_{yz \cdot x}$ should be calculated instead of r_{yz} in order not to include the effect of variable x. By using correlation coefficients, the partial correlation coefficient between variable y and z is given by the equation (3).

$$r_{yz \cdot x} = \frac{r_{yz} - (r_{xz} \times r_{xy})}{\sqrt{1 - {r_{xz}}^2} \times \sqrt{1 - {r_{xy}}^2}} \quad (3)$$

x, y, z : Variables
r_{yz} : Correlation coefficient between the variable y and z.
$r_{yz \cdot x}$: Partial correlation coefficient between the variable y and z which is controlling the effect of the variable x.

If the number of variables is more than three, the equation (4) gives the partial correlation coefficient between two variables by controlling the influence from other variables.

$$r_{ij \cdot rest} = \frac{-r^{ij}}{\sqrt{r^{ii} r^{jj}}} \quad (4)$$

r : Correlation matrix
r^{ij} : $(r^{-1})_{ij}$
$r_{ij \cdot rest}$: Partial correlation coefficient between x_i and x_j which is controlling the effect of the other variables

3. Results

Table 1 summarize Spearman rank correlation coefficients for [All]. Highlighted Spearman rank correlation coefficients in Table 1 are related to question combinations

between q2SA, q2K, q3SA, and q3K.

Table 1 Spearman's correlation coefficients for [All]. Highlighted Spearman's correlation coefficients are related to question combinations between q2SA, q2K, q3SA, and q3K.

[All]	q1SA	q2SA	q3SA	q4SA	q5SA	q1K	q2K	q3K	q4K	q5K
q1SA	—									
q2SA	0.17	—								
q3SA	0.13	0.39	—							
q4SA	0.18	0.35	0.26	—						
q5SA	-0.07	-0.16	-0.06	-0.20	—					
q1K	0.30	0.06	0.09	0.04	0.08	—				
q2K	0.11	0.29	0.26	0.20	-0.01	0.25	—			
q3K	0.07	0.27	0.30	0.18	-0.08	0.22	0.54	—		
q4K	0.12	0.21	0.17	0.25	-0.11	0.27	0.54	0.48	—	
q5K	-0.01	-0.11	-0.08	-0.13	0.39	-0.03	-0.24	-0.24	-0.33	—

By calculating VIF, it is confirmed that there is no classification which VIFs are greater than 5. The maximum value of VIFs for [All] is 1.4. This means that the possibility of multicollinearity is low among all classification provided by Rogerson (2001) [8].

Partial correlation coefficients are calculated by using correlation coefficients and visualized by a heat map. Figure 2 illustrates the heat map of partial correlation coefficients for [All].

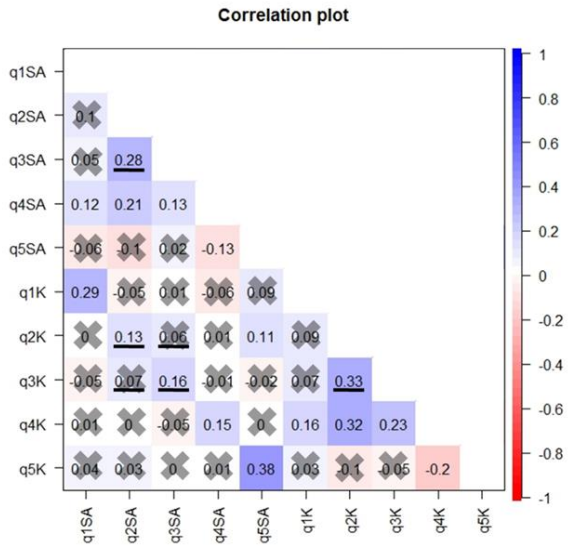

Figure 2 Heat map of partial correlation coefficients for [All]. The color (the gray level) of the line stands for the strength of correlation. The blue and red lines show positive and negative correlation respectively. The meaning of the sign "×" in the heat map is failing to the null hypothesis of Test for Association at the significant level of 0.05 (p-value > 0.05) or underpowered (statistical power is below the 0.8 threshold). The general recommendation of statistical power is 80% provided by Cohen (1988) [9]). Underlined partial correlation coefficients are related to question combinations between q2SA, q2K, q3SA, and q3K.

Among partial correlation coefficients related to question combinations between q2SA, q2K, q3SA, and q3K, five partial correlation coefficients (q3SA-q3K for [vote_K], q2K-q3K for [All], [Boy], [Girl], and [vote_SA]) are larger than a medium effect size of Cohen's index, 0.30 (Cohen, 1992) [7]. For these partial correlation coefficients, Confidence Interval (CI) is calculated. In addition to CI, the p-value of Test for Association and the statistical power of Post-Hoc Analysis for each partial correlation coefficient are summarized as shown below;

「q2K-q3K」

[All] $r = .33,\ p < .05,\ 1-\beta > .99,\ 95\%CI\ [.26, .40]$

[Boy] $r = .35,\ p < .05,\ 1-\beta > .99,\ 95\%CI\ [.25, .44]$

[Girl] $r = .31,\ p < .05,\ 1-\beta > .99,\ 95\%CI\ [.21, .40]$

[vote_SA] $r = .33,\ p < .05,\ 1-\beta > .99,\ 95\%CI\ [.25, .40]$

「q3SA-q3K」

[vote_K] $r = .40,\ p < .05,\ 1-\beta > .99,\ 95\%CI\ [.25, .53]$

The distribution of the answer results related to question combinations between q2SA, q2K, q3SA, and q3K are visualized by Bubble chart. In response to each Bubble chart, the Cross-tabulation is generated to summarize the frequency and percentage of answer set to question combination. To take examples of the Bubble chart and the Cross-tabulation, these of the question combination between q2K and q3K for [All] are shown in Figure 3 and Table 2 respectively.

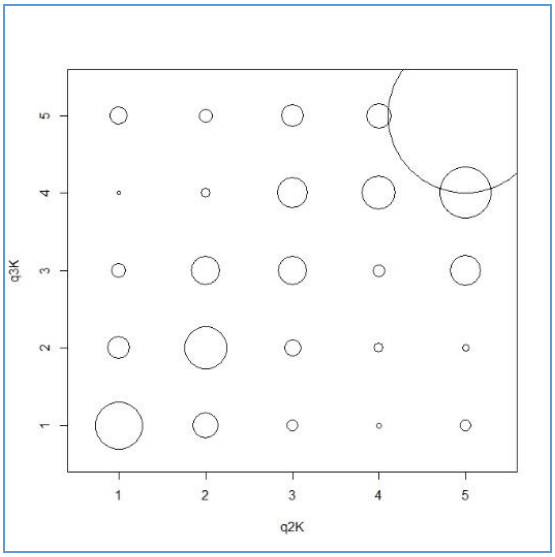

Figure 3 Bubble chart for q2K and q3K [All]. The size of circle stands for the frequency of the answer set to questions. X-axis and Y-axis show the answer options (from 1 to 5) of q2K and q3K respectively.

Table 2 Cross-tabulation of the frequency and percentage of the answer set to questions for q2K and q3K [All]

		q2K				
		[1]	[2]	[3]	[4]	[5]
q3K	[5]	**18(2.6%)**	**14(2.0%)**	**23(3.4%)**	**25(3.6%)**	**156(22.8%)**
	[4]	**4(0.6%)**	**10(1.5%)**	**31(4.5%)**	**34(5.0%)**	**52(7.6%)**
	[3]	**15(2.2%)**	**29(4.2%)**	**29(4.2%)**	**12(1.8%)**	**31(4.5%)**
	[2]	**23(3.4%)**	**43(6.3%)**	**17(2.5%)**	**10(1.5%)**	**7(1.0%)**
	[1]	**48(7.0%)**	**26(3.8%)**	**11(1.6%)**	**6(0.9%)**	**11(1.6%)**

4. Discussion and Conclusions

(1) Strong cohesion among South African children

About the question combination [q2SA-q3SA], students who answer that both q2SA and q3SA are 5 are in the majority for all classification. The percentage of the answer result (q2SA = 5, q3SA = 5) for each classification is about 40%. Figure 4 is the Bubble chart of the question combination between q2SA and q3SA for [All] divided into four sections. Corresponding to the Figure 4, the detail of answer results is summarized in Table 3.

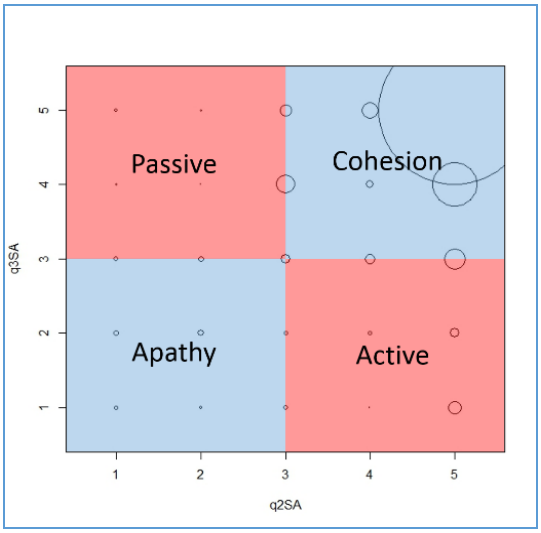

Figure 4 Bubble chart for q2SA and q3SA [All]. The size of circle stands for the frequency of the answer set to questions. X-axis and Y-axis show the answer options (from 1 to 5) of q2SA and q3SA respectively.

Table 3 Cross-tabulation of the frequency and percentage of the answer set to questions for q2SA and q3SA [All]

		q2SA				
		[1]	[2]	[3]	[4]	[5]
q3SA	[5]	6(0.9%)	5(0.7%)	22(3.2%)	31(4.5%)	281(41%)
	[4]	4(0.6%)	3(0.4%)	35(5.1%)	15(2.2%)	83(12.1%)
	[3]	9(1.3%)	10(1.5%)	17(2.5%)	19(2.8%)	40(5.8%)
	[2]	10(1.5%)	12(1.8%)	8(1.2%)	7(1%)	18(2.6%)
	[1]	8(1.2%)	6(0.9%)	9(1.3%)	2(0.3%)	25(3.6%)

The interpretation of each section in Figure 4 is as shown below;

The top right section [Cohesion]:

The answers to both q2SA and q3SA are high. Students in this section think they can share the joy with the ingroup each other.

The top left section [Passive]:

The answer to q2SA is low, while the answer to q3SA is high. Students in this section think they are not interested in sharing the joy with the ingroup, while the ingroup shares the joy with them.

The bottom right section [Active]:

The answer to q2SA is high, while the answer to q3SA is low. Students in this section think they can share the joy with the ingroup, while the ingroup is not interested in sharing the joy with them.

The bottom left section [Apathy]:

The answers to both q2SA and q3SA are low. Students in this section do not think they can share the joy with the ingroup each other.

As can be seen from the figure, the circle located in the upper right corner (q2SA = 5, q3SA = 5) is particularly large. In conclusion, it can be interpreted that students show their strong cohesion with the ingroup in any classification, from the discussion about Question combination [q2SA-q3SA].

(2) No Nationality Bias among [vote_K]

It is examined that the correlation of the cohesion from the ingroup and the outgroup students think by focusing on the question combination [q3SA-q3K]. Figure 5 is the Bubble chart of [vote_K]. Corresponding to the figure, the detail of answer results is summarized in Table 4.

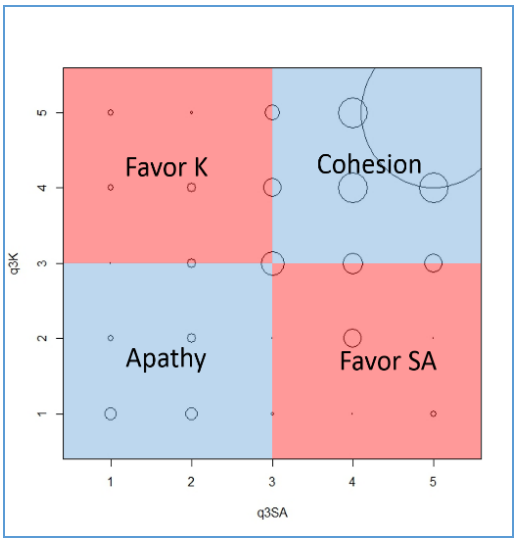

Figure 5 Bubble chart for q3SA and q3K [vote_K]. The size of circle stands for the frequency of the answer set to questions. X-axis and Y-axis show the answer options (from 1 to 5) of q3SA and q3K respectively.

Table 4 Cross-tabulation of the frequency and percentage of the answer set to questions for q3SA and q3K [vote_K]

		q3SA				
		[1]	[2]	[3]	[4]	[5]
q3K	[5]	2(1.4%)	1(0.7%)	5(3.5%)	10(6.9%)	49(34%)
	[4]	2(1.4%)	3(2.1%)	6(4.2%)	10(6.9%)	10(6.9%)
	[3]	0(0%)	3(2.1%)	8(5.6%)	7(4.9%)	6(4.2%)
	[2]	2(1.4%)	3(2.1%)	0(0%)	6(4.2%)	0(0%)
	[1]	4(2.8%)	4(2.8%)	1(0.7%)	0(0%)	2(1.4%)

The interpretation of each section in these figures is as shown below;

The top right section [Cohesion]:

The answers to both q3SA and q3K are high. Students in this section think both the ingroup and the outgroup share the joy with them.

The top left section [Favor K]:

The answer to q3SA is low, while the answer to q3K is high. Students in this section think the outgroup shares the joy with them.

The bottom right section [Favor SA]:

The answer to q3SA is high, while the answer to q3K is low. Students in this section think the ingroup shares the joy with them.

The bottom left section [Apathy]:

The answers to both q3SA and q3K are low. Students in this section do not think both the ingroup and the outgroup share the joy with them.

The majority of answer results particularly concentrates on the upper right corner (q2SA = 5, q3SA = 5) of Figure 5 for [vote_K]. Additionally, it has been observed that the partial correlation coefficient between q3SA and q3K for [vote_K] is 0.40. It is larger than a medium effect size of Cohen's index, 0.30 (Cohen, 1992) [7] and it means that there is a remarkable positive correlation in this question combination. These results lead to the conclusion that [vote_K] have no bias about their impression of how the other shares the joy with them regardless of whether the other is the ingroup member or the outgroup.

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